

Adaptive Neuro Fuzzy Based Maximum Torque Control of Three Phase Induction Motor

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Abstract

This paper manages the Maximum Torque Control of IM drives utilizing ANFIS. In modern control hypothesis, the IM is depicted by various arithmetical models, as per the engaged control technique. The proposed approaches straightforwardly direct the machine stator flux as indicated by the desirable torque, utilizing an optimal stator flux reference. In this manner, the proposed technique is appropriate for motor control conspires that depend on coordinate motion control, for example, coordinate torque control or direct torque vector control. Utilizing ANFIS, especially the neural systems, execution and operation of acceptance IM is progressed. This paper presents ANFIS based MTC of Three-phase IM. The execution of the intellectual controller has been examined through MATLAB/Simulink condition, for various operational conditions. At last, the outcomes are watched that ANFIS based controllers give preferable reactions over alternate controllers

Keywords: ANFIS, Torque Control, Induction Motor, MATLAB/Simulink.

Introduction

For any machine we expect less error, most extreme output for that we have to control the torque. In three phases IM the maximum torque control can be accomplished in various techniques. The controlling of most extreme torque should be possible in customary controllers, for example, corresponding controller, relative in addition to essential controller however these are particularly helpful in steady state and for linear systems. In any case, the P, PI controller has primary disfavor is tuning of parameters K_p, K_i, K_d, T_d, T_i (and also other problems like the high starting overshoot, sensitivity to controller gains and sluggish response due to sudden disturbance) In about the same period, there were also advances in control methods and Artificial Intelligence (AI) techniques.. Artificial Intelligent strategies mean utilization of master framework, fluffly rationale, neural systems and hereditary calculation. Experts soon understood that the control of IM drives can be improved by receiving automated interpretation based techniques like The Artificial Intelligence (AI) methods, for example, Expert System (ES), Fuzzy Logic (FL), Artificial Neural Network (ANN), and Genetic Algorithm (GA) have been connected broadly responsible for

Control of IM drives. Among all the branches of AI, the ANFIS appears to have more significant effect on Power electronics and IM Drives.

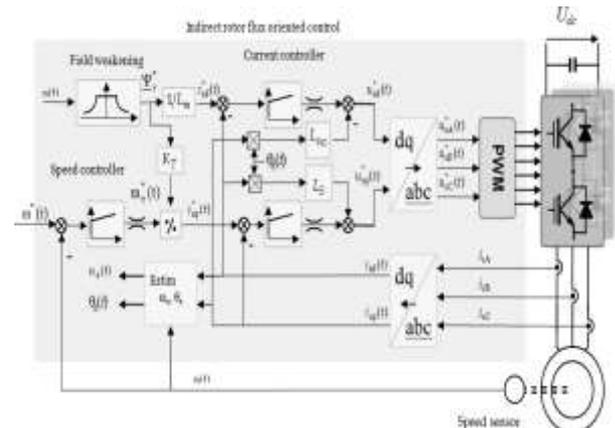


Fig.1.General Configuration of Maximum Torque Control of Three Phase Induction Motor

The ANFIS is able of learning the preferred mapping involving the inputs and outputs signals of the system without Significant the exact arithmetical representation of the system. Since the ANFIS do not use the arithmetical representation of the system, the same. The ANFIS are excellent estimators in non linear systems [6] - [8]. Various ANFIS based control approach have been implemented for MTC of induction motor drive to conquer the system drawback. In this paper ,NN flux point estimation, segment range and switching vector range design projected.

Adaptive Neuro Fuzzy Inference System

A neuro fuzzy structure is a fuzzy structure that practices a derived learning algorithm or stimulated by the theory of neural networks to determine its factors (fuzzy set and fuzzy rules) by handling data models. NFC is the arrangement of Fuzzy Inference System (FIS) and NN. The fuzzy logic is activated permitting to the fuzzy rule and NN is accomplished based on the training data. The neural network formation data set is generated by fuzzy rules. The NFC function is clarified in the following section.

Fuzzy Logic Controller

Fuzzy control system is a control system based on fuzzy logic –a mathematical system that analyzes along input values in terms of logical variables that take on continuous values between Zeros and ones.

Fuzzy logic gives the linguistic approaches control adaptation from practiced familiarity in automatic control schemes. In the fuzzy control scheme, the operation of controller is mainly constructed on fuzzy rules, which are created using fuzzy set theory. Fuzzy controller plays an important role in the compensation of PQ problem .the steps involved in fuzzy controller are fuzzification, decision making, and defuzzification is the method of changing the crisp value into fuzzy value.

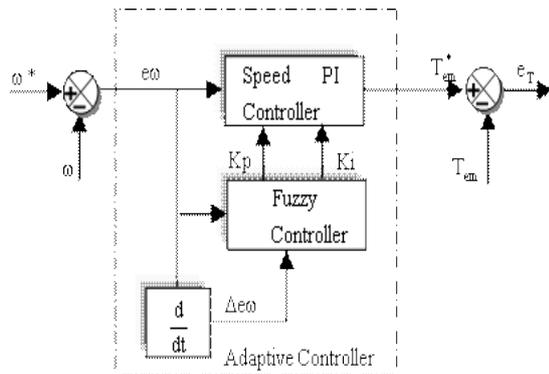


Fig.2.Proposed FLC structure

Fuzzification strategy

- Data base building
- Rule base elaboration
- Interface machine elaboration
- Defuzzification strategy.

Also, outline of FLC can give keen both small signal and large signal dynamic execution at same time, which is unlikely with linear control method. The advancement of fuzzy logic approach here is constrained to the plan and structure of the controller. The contributions of FLC are characterized as the voltage blunder, and change of error. Fuzzy sets are characterized for each information and output variable. There are five fuzzy levels which described in Rule table. The enrollment capacities for input and output factors are triangular. The min-max technique interface engine is used. The fuzzy technique utilized as a part of this FLC is focal point of territory. The entire arrangement of control rules is appeared in Table.1. Each of the 25 control rules speaks to the coveted controller reaction to a specific circumstance. Figure establishes the square chart of a FLC.

Table 1. Fuzzy tuning rules

	e(ω) Δe(ω)	N	N	N	Z	P	P	P
		L	M	S	E	S	M	B
k _p	N	L	M	S	M	S	M	L
	Z	L	M	L	Z	L	M	L
	P	L	M	L	Z	L	M	L
k _i	N	Z	S	M	L	M	S	Z
	Z	Z	S	M	L	M	S	Z
	P	Z	M	L	L	L	M	Z

B. Designing & Training of Ann

An Artificial neural Network (ANN), regularly called a "neural Network" (NN), is a systematic model or computational model in view of natural neural systems. It comprises of an interrelated collecting of artificial neurons and procedures data utilizing a connectionist way to deal with calculation. By and large an ANN is a versatile framework that progresses its structure in light of outside or interior data that moves through the system along with the learning stage. In more functional terms neural systems are non-direct measurable information demonstrating apparatuses. They can be utilized to display complex connections amongst information sources and yields or to discover designs in information. NN is a manmade brainpower method that is utilized for producing preparing informational collection and testing the connected info information. A sustain forward sort NN is utilized The structure of the NN is described as follows.

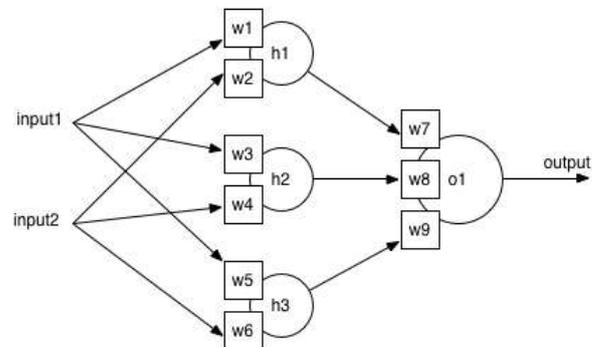


Fig.3.Structure of the NN for capacitor Voltage Regulation.

In Figure-3., the input layer, hidden layer and output layer of the system are (H11, H12), (H21 ,H22... ..H2N), and H31 individually. The heaviness of the input layer to hidden layer is indicated as w11, w12, w1N, w21, w22, and w2N. The weight of the hidden layer to output layer is meant as w211, w221, w2N1. Here, the Back Propagation (BP) preparing calculation is utilized for preparing the system. Figure-9 Shows the Proposed System NN Structure.

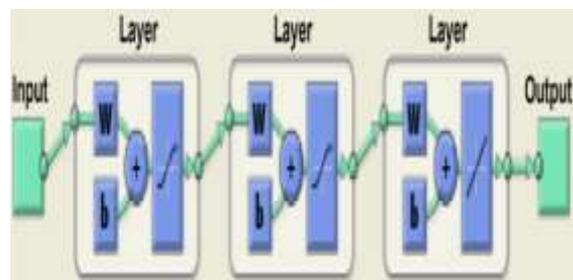


Fig.4.Proposed System NN structure

ANFIS controller, which turns into an incorporated technique for approach for the control purposes and yields brilliant outcomes, which is the feature of this paper [1]. In the outlined ANFIS scheme, neural

system methods are utilized to choose an appropriate control base, which is accomplished utilizing the back proliferation calculation. This incorporated approach enhances the framework execution, cost-adequacy, effectiveness, dynamism, and unwavering quality of the planned controller. ANFIS controller is utilized to decrease the power mistake to zero.

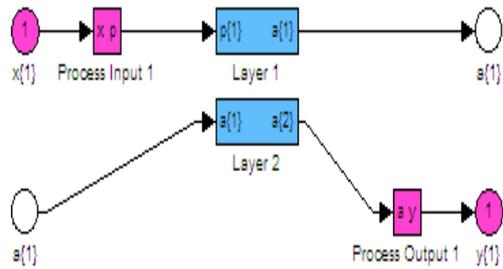


Fig.5.Simulation of proposed NN structure

Results and Discussion

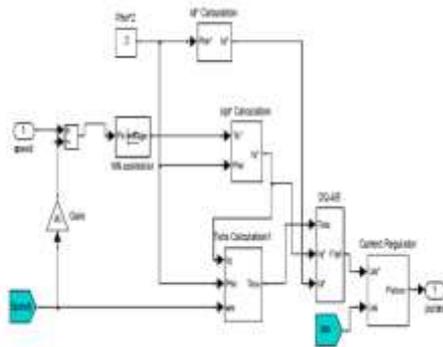


Fig.6. Simulink diagram of the Three Phase Induction motor with the Neuro Controllers

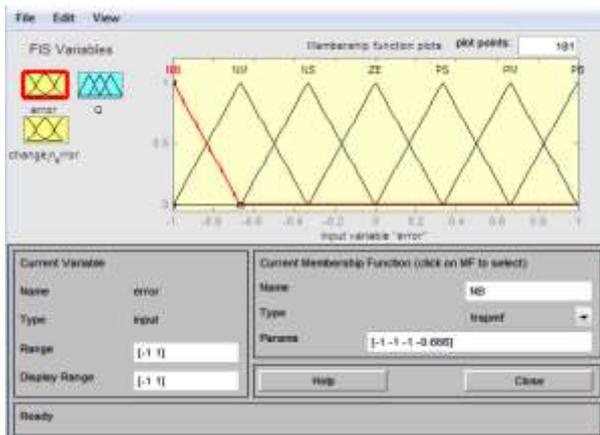


Fig.7.Membership Functions for Input-1.

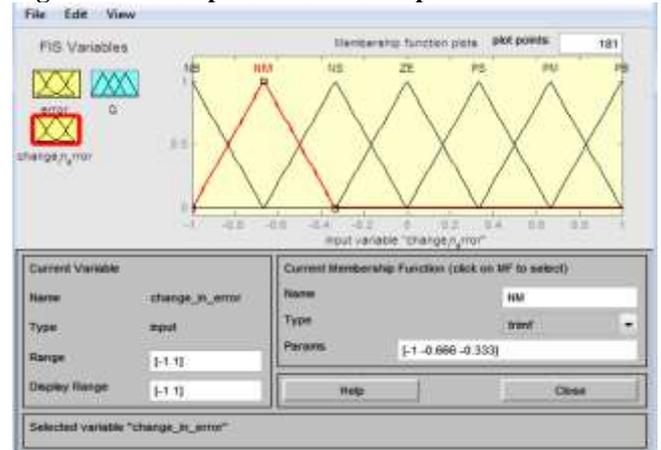


Fig.8.Membership Functions for Input-1.

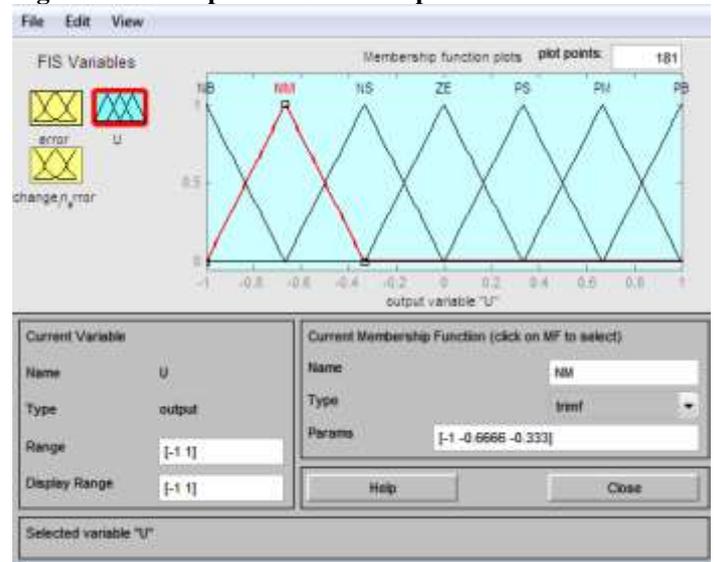


Fig.8.Membership Functions for output.

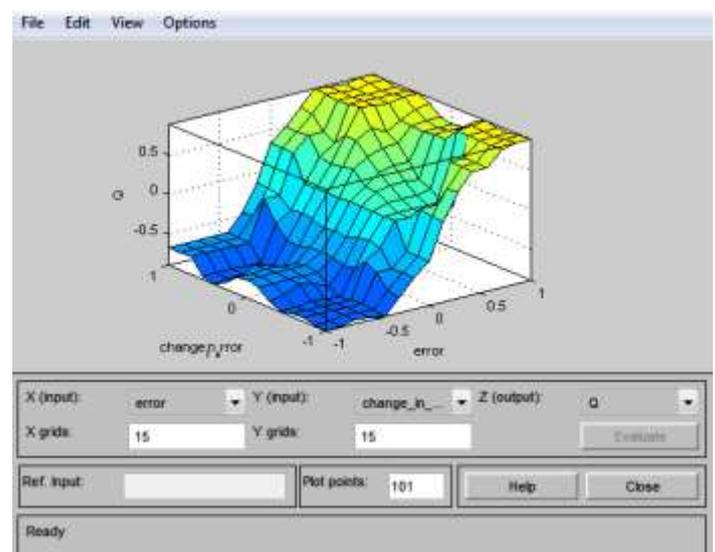


Fig.9.SurfaceViewer

In this section, Matlab / Simulink software is used to simulate the complete MTC system to look at the performance of the induction motor. Simulation conditions are indicated as: speed is 200 rpm and orientation flux is 0.9 Wb the preliminary load torque is 30 Nm, 0.2 seconds the load torque set to 30 Nm; the simulation time is 0.25 seconds. The figure shows the relative study of MTC with the PI controller. Figure.6 shows the three-phase IM with the anticipated control device. Figures 10 shows the speed response in which the speed reaches the steady state at 200 rpm at 0.13. Figure.11 shows the torque response reached 30Nm much faster with the conventional controller. Figure 9 shows the capacitor voltage that will compensate for the induction motor speed error and the fastest response with the fuzzy controller. Simulation of induction motors in conventional and ANFIS are performed in MATLAB / SIMULINK. A complete simulation representation was developed for drive with induction motor powered by inverter incorporating the proposed neuro controller. Let's examine the dynamic performance of the induction motor based on the proposed ANFIS. The proposed ANFIS was superior to conventional IM speed, conventional speed, and FLC pulse response. A. Figures 7, 8 and 9 show the torque, torque and velocity characteristics of ANFIS respectively. It seems that the increase time decreases drastically when the anfis is added to the simulation model and both results are taken over the same time period. In the simulation based on the neural networks, it is evident from the simulation results shown in Figure 7 (b) and Figure 7 (c), the characteristic of the torque speed converges to zero in less time. Neuro controller has no excess and installs faster. It is also noted that there is no stationary error in speed response during operation when the neuro controller is activated. From the results we can see that the response time of the induction motor to the time domain specification is better than the use of the PI controller through the neural network (rear propagation algorithm).

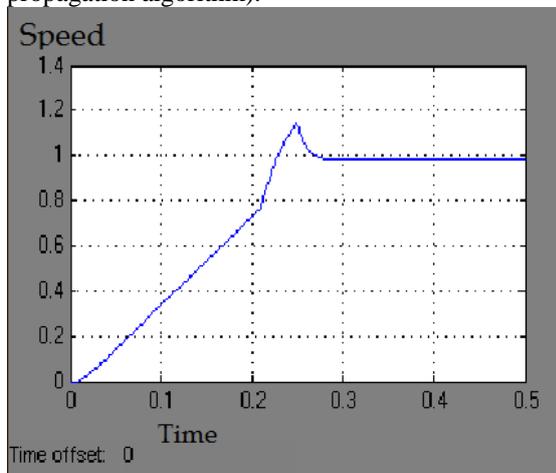


Fig 10: Speed versus time (secs)

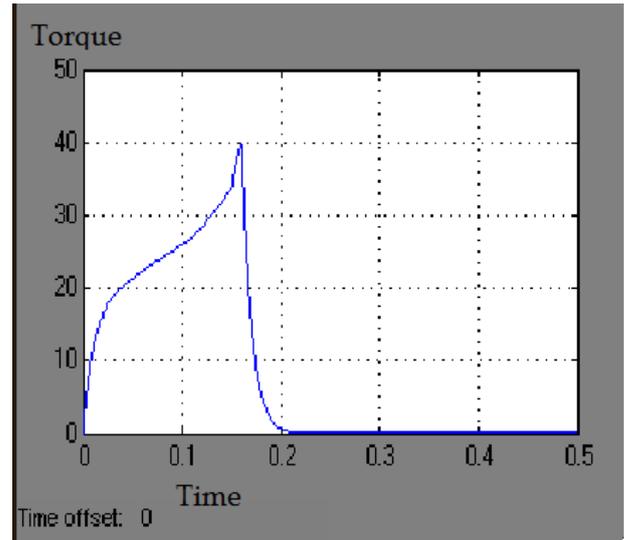


Fig .11: Torque versus time (secs)

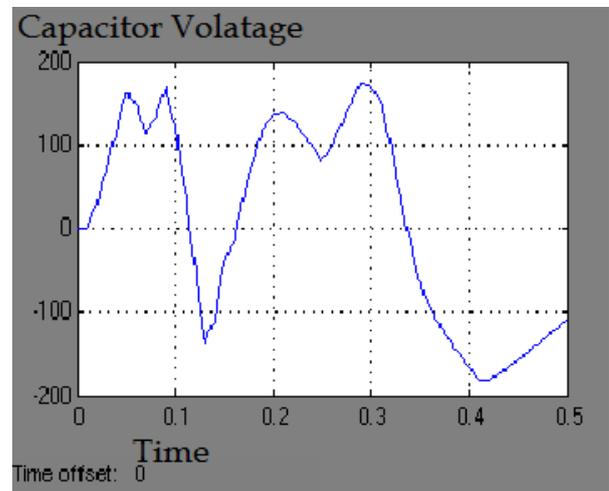


Fig 12: V_{Cap} versus time (secs)

2: Comparison Table for Controllers

controller	Speed		Torque			V _{Cap}	
	Overshoot	Settling time(sec)	Overshoot	Settling time (sec)	Over shoot	Settling time(sec)	
PI	1.19	0.28	80	0.25	6	0.23	
ANFIS	0.01	0.20	18	0.2	1.5	0.1	

Conclusion

The maximum torque of the three -phase induction motor is attaining by means of the ANFIS and the responses are evaluated with the PI controller it has been observed that the ripple substance and the robust response to the sudden changes are reduced. the simulation speed increases even with respect to the customary controller. From the results of the simulation we can see that the performance of the drive is improved for a shorter acceleration time and maximum torque is reached. The performance of ANFIS has been studied through the MATLAB / Simulink environment. From the results we can see

that when using ANFIS (back propagation algorithm) the response of the induction motor in terms of time domain specifications is better than using the PI controller.

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